CLAIMS

1. A gas sensor comprising:

a to-be-held member including a distal-end-side holding surface and a proximal-end-side holding surface located on the proximal end side with respect to the distal-end-side holding surface;

a tubular metallic shell including a stepped portion projecting radially inward from its inner circumferential surface, and adapted to hold the to-be-held member therein while surrounding the to-be-held member from radially outside and supporting the distal-end-side holding surface of the to-be-held member by a support surface of the stepped portion; and

a first packing abutting the proximal-end-side holding surface of the to-be-held member and the inner circumferential surface of the metallic shell, wherein

the first packing is disposed in an acute-angle clearance formed between the proximal-end-side holding surface of the to-be-held member and the inner circumferential surface of the metallic shell such that the first packing has a wedge-like cross section and is pressed against the proximal-end-side holding surface of the to-be-held member and the inner circumferential surface of the metallic shell.

2. A gas sensor according to claim 1, wherein the to-be-held member is a gas detection element having a projection which includes the distal-end-side holding surface and the proximal-end-side holding surface and which projects radially

outward, the gas detection element assuming a closed-bottomed tubular shape with an axially distal end closed.

3. A gas sensor according to claim 1, further comprising a gas detection element extending along the axial direction, wherein the to-be-held member is an element holder which has the distal-end-side holding surface, the proximal-end-side holding surface, and an opening through which the gas detection element is passed.

4. A gas sensor according to claim 2 or 3, further comprising a charged seal layer, which is formed by means of charging a powder into a clearance between the outer circumferential surface of the gas detection element and the inner circumferential surface of the metallic shell in a region located toward the proximal end of the gas sensor with respect to the first packing.

5. A gas sensor according to any one of claims 1 to 4, wherein the first packing is formed by axially pressing and plastically deforming a wire packing, which has been inserted into the clearance between the proximal-end-side holding surface of the to-be-held member and the inner circumferential surface of the metallic shell, such that the first packing has a wedge-like cross section.

6. A gas sensor according to any one of claims 1 to 5, wherein

the proximal-end-side holding surface of the to-be-held member and the inner circumferential surface of the metallic shell assume respective shapes such that in at least a distal-end-side portion of the clearance, the angle formed by

the proximal-end-side holding surface and the inner circumferential surface decreases toward the distal end side; and

the first packing is disposed to extend to the portion of the clearance where the angle formed by the proximal-end-side holding surface and the inner circumferential surface decreases toward the distal end side.

7. A gas sensor comprising:

a gas detection element assuming a closed-bottomed tubular shape with an axially distal end closed, including an outer electrode formed on its outer circumferential surface, and including a projection projecting radially outward;

a tubular metallic shell including a stepped portion projecting radially inward from its inner circumferential surface, and adapted to hold the gas detection element therein while surrounding the gas detection element from radially outside and supporting a distal end surface of the projection by a support surface of the stepped portion, the support surface of the stepped portion abutting the outer electrode formed on the distal end surface of the projection to thereby be electrically connected with the outer electrode; and

a first packing abutting a proximal end surface of the projection and the inner circumferential surface of the metallic shell, wherein

the first packing is disposed in an acute-angle clearance formed between the proximal end surface of the projection and the inner circumferential surface of the

metallic shell such that the first packing has a wedge-like cross section and is pressed against the proximal end surface of the projection and the inner circumferential surface of the metallic shell.

8. A gas sensor comprising:

a gas detection element assuming a closed-bottomed tubular shape with an axially distal end closed, including an outer electrode formed on its outer circumferential surface, and having a projection projecting radially outward;

a tubular metallic shell including a stepped portion projecting radially inward from its inner circumferential surface, and adapted to hold the gas detection element therein while surrounding the gas detection element from radially outside and supporting a distal end surface of the projection by a support surface of the stepped portion;

a first packing abutting a proximal end surface of the projection and the inner circumferential surface of the metallic shell; and

a second packing of metal disposed between the distal end surface of the projection and the support surface of the stepped portion, and abutting the support surface of the stepped portion and the outer electrode formed on the distal end surface of the projection to thereby electrically connect the metallic shell and the outer electrode, wherein

the first packing is disposed in an acute-angle clearance formed between the proximal end surface of the projection and the inner circumferential surface of the metallic shell such that the first packing has a wedge-like

cross section and is pressed against the proximal end surface of the projection and the inner circumferential surface of the metallic shell.

9. A gas sensor according to claim 7 or 8, further comprising a charged seal layer, which is formed by means of charging a powder into a clearance between the outer circumferential surface of the gas detection element and the inner circumferential surface of the metallic shell in a region located toward the proximal end of the gas sensor with respect to the projection of the gas detection element.

10. A gas sensor according to any one of claims 7 to 9, the first packing is made of metal and abuts the outer electrode formed on the proximal end surface of the projection and the inner circumferential surface of the metallic shell to thereby electrically connect the outer electrode and the metallic shell.

11. A gas sensor according to any one of claims 7 to 10, wherein the first packing is formed by axially pressing and plastically deforming a wire packing, which has been inserted into the clearance between the proximal end surface of the projection and the inner circumferential surface of the metallic shell, such that the first packing has a wedge-like cross section.

12. A gas sensor according to any one of claims 7 to 11, wherein the proximal end surface of the projection and the inner circumferential surface of the metallic shell assume respective shapes such that in at least a distal-end-side portion of the clearance, the angle formed by the proximal

end surface and the inner circumferential surface decreases toward the distal end side; and

the first packing is disposed to extend to the portion of the clearance where the angle formed by the proximal end surface and the inner circumferential surface decreases toward the distal end side.

13. A method of manufacturing a gas sensor comprising:

a gas detection element assuming a closed-bottomed tubular shape with an axially distal end closed, including an outer electrode formed on its outer circumferential surface, and including a projection projecting radially outward;

a tubular metallic shell including a stepped portion projecting radially inward from its inner circumferential surface, and adapted to hold the gas detection element therein while surrounding the gas detection element from radially outside and supporting a distal end surface of the projection by a support surface of the stepped portion, the support surface of the stepped portion abutting the outer electrode formed on the distal end surface of the projection to thereby be electrically connected with the outer electrode; and

a first packing abutting a proximal end surface of the projection and the inner circumferential surface of the metallic shell,

the method comprising:

an element-inserting step of inserting the gas detection element into the metallic shell;

a wire-packing-inserting step of inserting a wire

packing, which is to become the first packing, into the metallic shell; and

a first-packing-forming step of axially pressing the wire packing inserted into the metallic shell such that the wire packing is plastically deformed so as to form the first packing which is disposed in an acute-angle clearance formed between the proximal end surface of the projection and the inner circumferential surface of the metallic shell such that the first packing has a wedge-like cross section and is pressed against the proximal end surface of the projection and the inner circumferential surface of the metallic shell.

14. A gas sensor comprising:

a gas detection element assuming a closed-bottomed tubular shape with an axially distal end closed, having an outer electrode formed on its outer circumferential surface, and including a projection projecting radially outward;

a tubular metallic shell including a stepped portion projecting radially inward from its inner circumferential surface, and adapted to hold the gas detection element therein while surrounding the gas detection element from radially outside and supporting a distal end surface of the projection by a support surface of the stepped portion;

a first packing abutting a proximal end surface of the projection and the inner circumferential surface of the metallic shell; and

a second packing of metal disposed between the distal end surface of the projection and the support surface of the stepped portion, and abutting the outer electrode formed on

the distal end surface of the projection and the support surface of the stepped portion to thereby electrically connect the outer electrode and the metallic shell,

the method comprising:

a second-packing-inserting step of inserting the second packing into the metallic shell;

an element-inserting step of, after the second-packing-inserting step, inserting the gas detection element into the metallic shell;

a second-packing-pressing step of, after the element-inserting step, axially pressing the gas detection element and the second packing inserted into the metallic shell to thereby bring the second packing into close contact with the support surface of the stepped portion;

a wire-packing-inserting step of, after the second-packing-pressing step, inserting a wire packing, which is to become the first packing, into the metallic shell; and

a first-packing-forming step of axially pressing the wire packing inserted into the metallic shell such that the wire packing is plastically deformed so as to form the first packing which is disposed in an acute-angle clearance formed between the proximal end surface of the projection and the inner circumferential surface of the metallic shell such that the first packing has a wedge-like cross section and is pressed against the proximal end surface of the projection and the inner circumferential surface of the metallic shell.